



PETROLEUM PRODUCTS

BACKGROUND

Petroleum products such as gasoline, kerosene, jet fuel, home heating oil, lubricants, and those used in medicines, fertilizers, foodstuffs, plastic ware, building materials, paints, and textiles are produced from crude oil which is a naturally-occurring oily, bituminous liquid composed of various organic chemicals. Crude oils vary widely in both physical and chemical properties. They are generally considered to be a complex mixture of hydrocarbons. Crude oil and refined petroleum products contain four major groups of hydrocarbons: alkanes, olefins, alicyclics, and aromatics.

Alkanes (or paraffins) average approximately 20% of the oil fraction of crude oils, but range in amounts from practically zero to close to 100% in different oils. These compounds containing primarily aliphatic (straight-chain) hydrocarbons have relatively low toxicities. Some alkanes of five or more carbons have strong narcotic properties following inhalation exposure at high concentrations. The olefins (or alkene) fraction contains unsaturated aliphatic hydrocarbons. These compounds exhibit little toxicity other than weak anesthetic properties. The content of alicyclic hydrocarbons (*i.e.*, naphthenes) also varies among crudes, but is generally considered to be about 50% of the oil fraction. Naphthenes or cycloparaffins are saturated and unsaturated alicyclic hydrocarbons that resemble aliphatic hydrocarbons in their toxicity since they act as general anesthetics and have depressant effects on the central nervous system with a relatively low degree of acute toxicity. These compounds are not cumulative and little, if any, significant toxicity has been noted upon prolonged exposure to naphthene vapors. Aromatics generally do not account for more than 20% of the oil fraction. Aromatic hydrocarbons, predominantly benzene, have generally been regarded as the most toxic fraction of petroleum and petroleum solvents. The toxicity of toluene, xylenes, and other alkylated benzene derivatives is considerably lower.

Refined petroleum products used as fuels have many chemical constituents. As an example, gasoline, the major refined petroleum product, normally contains more than 200 different chemicals. Alkanes and aromatic compounds generally constitute the largest fraction of gasoline. Also, gasoline typically contains a variety of additives for improving engine performance. Methyl tertiary-butyl ether (MTBE) is an example of a chemical additive used as an octane enhancer in oxygenated and reformulated gasoline. It is found in many drinking water wells, but mostly at levels below that known to cause human health effects. The composition of gasoline varies as a function of the crude oil, the refinery process, the gasoline blending makeup of different grades, the climate of the marketing region, and the brand. Some of the primary constituents of petroleum products include benzene, toluene, ethylbenzene, and xylenes. These components are often referred to as the **BTEX** complex.

HEALTH EFFECTS

The primary component of concern in the **BTEX** complex is benzene, which has been classified as a known human carcinogen by the U.S. Environmental Protection Agency (EPA). Acute benzene exposure causes central nervous system depression. Brief exposure to 3,000 parts per million (ppm) is irritating to the eyes and respiratory tract, and continued exposure may cause euphoria, nausea, staggering gait, and coma. Inhalation of lower concentrations (250 ppm to 500 ppm) produces vertigo, drowsiness, headache, and nausea. Studies in animals indicate that inhalation of high concentrations of benzene produce mucous membrane and pulmonary irritation, and may result in pulmonary edema. Chronic exposures to benzene induce well-recognized hematotoxicity, especially bone marrow suppression. Benzene has an odor threshold in water of 2.0 ppm, and a taste threshold of 0.4-4.5 ppm. The EPA has established the maximum contamination level (MCL) of benzene in drinking water supply at 5.0 parts per billion (ppb). Virginia has an ambient surface water quality standard for benzene of 5.0 ppb. EPA has also recommended a short-term (10 days) advisory level for benzene in water at 200 ppb for children. The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) in the workplace for benzene is 1.0 ppm. Since benzene is the most water-soluble fraction of the **BTEX** complex, it is also found to be in the highest concentration in petroleum contaminated water.

Toluene is found in gasoline, paints, paint thinners, adhesives, fingernail polish, and other petroleum-based products. Toluene has an odor threshold of 2.14 ppm in air. Acute adverse health effects from exposure to toluene include headache, confusion, and memory loss, depending on the concentration, duration, and route of exposure. Brief exposure to a concentration of 100 ppm causes psychomotor and perceptual impairment, suggesting central nervous system dysfunction. Exposures to 500 ppm to 800 ppm cause progressively increasing headache, drowsiness, nausea, fatigue, weakness, and confusion. Toluene also may interact with some common medicines like aspirin and acetaminophen to affect hearing. Ingestion of toluene-contaminated drinking water may temporarily affect the kidneys. In most cases, the kidneys will return to normal after the exposure stops. The EPA MCL for toluene in drinking water is 1.0 ppm. The EPA Health Advisory for toluene in drinking water for children is 20 ppm for 1 day and 2.0 ppm for 10 days. The OSHA PEL for toluene in the workplace is 200 ppm. Studies in workers and animals exposed to toluene indicate that toluene has not been shown to cause cancer.

Ethylbenzene is a colorless liquid that smells like gasoline, with an odor threshold of 2.0 ppm in air. It occurs naturally in coal tar and petroleum, and it is found in paints, inks, carpet glues, varnishes, and insecticides. Gasoline contains about 2% (by weight) ethylbenzene. Ethylbenzene is an irritant of the skin and mucous membranes. At high concentrations, it causes narcosis in animals. Humans briefly exposed to 1,000 ppm experienced eye irritation, but tolerance developed rapidly; exposure at 2,000 ppm caused lacrimation, nasal irritation, and vertigo; exposure at 5,000 ppm produced intolerable irritation of the eyes and nose. At chronic exposures exceeding 100 ppm, there were complaints of fatigue, sleepiness, headache, and mild irritation of the eyes and respiratory tract. Studies to date indicate that ethylbenzene is neither carcinogenic nor teratogenic in humans. The EPA MCL for ethylbenzene is 0.7 ppm. The EPA Health Advisory for ethylbenzene in drinking water is 30 ppm (1 day - child) and 3.0 ppm (10 days - child), and a lifetime advisory for adults of 0.7 ppm. The OSHA PEL for ethylbenzene in the workplace is 100 ppm.

Xylene is a colorless liquid with a sweet odor. Xylene has an odor threshold of about 2.2 ppm in water. Xylene exists in three forms: meta-xylene, ortho-xylene, and para-xylene. Chemical industries produce xylene from petroleum, and it is found naturally in petroleum and coal tar. Xylene vapor is an irritant of the eyes, mucous membranes, and skin; at high concentrations it causes narcosis. Air levels of 60 ppm to 350 ppm have produced giddiness, anorexia, and vomiting. Volunteers exposed to 460 ppm for 15 minutes had a slight tearing and light-headedness. A level of 230 ppm was not considered to be objectionable to most of these same volunteers. Exposure of pregnant women to high levels of xylene may be teratogenic and cause harmful effects to the fetus. Studies of unborn animals indicate that high concentrations of xylene may cause an increase in the number of deaths, decreased weight, skeletal changes, and delayed skeletal development. Data from animal studies indicate that xylene is not carcinogenic. The EPA MCL for total xylenes in drinking water is 10.0 ppm. The 1-day, 10-day, and long-term EPA Health Advisory for children exposed to xylene is 40 ppm. The Health Advisory for long-term exposure in adults is 100 ppm. The OSHA PEL for xylene in the workplace is 100 ppm.

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